6 Return Track and Triangular Junction Wiring

6.1 Introduction

Return track wiring problems occur only with 2-rail layouts without loco-borne control. Railways operated by battery-powered locomotives do not require track wiring and can therefore dispense with the complexities of return track wiring, but some care is still required with DCC, radio or infra-red control systems where track feeds are used.

In '3-rail' layouts the position of the third rail/stud contact studs/overhead wiring remains unchanged in relation to the running rails and no special wiring is required to accommodate return tracks. For example, a train traversing a single track return loop can regain the main line without stopping, only the turnout needs to be reversed to complete the movement. This simplification greatly compensates for the need to fit individual locomotives with reversing switches (Section 2.3.1).

In 2-rail, the electrification standard is that with the right hand rail positive the train will move forward (Part 1, Section 1.8). Using the above example, a train traversing a single track return loop will find that, at the exit point, the main line polarity does not match the loop polarity which must be reversed to allow the train to proceed. This situation applies to simple layouts having a single control unit and to larger layouts using cab control where the train is controlled by a single control unit throughout its journey. On larger layouts using area control the problem can be reduced by selecting area boundaries to coincide with the change-over points. All that is needed then is to match control unit outputs. Area control and cab control are dealt with in Section 5.

In conventional layouts without return tracks it is generally recommended that the return rail dropper wires are connected to a common return cable to simplify the wiring system. However, where return tracks occur it is often necessary to reverse both the feed and the return connections so that a particular section of track can have its polarity matched to that of an adjacent section. Where these sections occur the return wires, with their associated feed wires, are both routed via double-pole section switches.

In a DCC, radio or infra-red control system with track pick up, the loco borne control means that forward is always the same direction no matter what polarity the track is. This means that at first sight all that is required is to break both rails at some point in the loop so that the feed and return are not connected through the loop. However, as the locomotive crosses the break, its pickups will span the gap and create a short. This can be avoided by having a short section, longer than the longest locomotive, which is fed from a bridge rectifier, as shown in Figure 6-3. Since command control is used, the locomotive can pass in either direction through the rectified section.

In the following notes the turnout crossing polarity switching has not been included to avoid cluttering the diagrams. Crossing polarity is dealt with in detail in Section 3.

Because there are alternative ways of supplying power to return tracks the particular method adopted will depend on the overall design of the layout wiring which, in turn, will depend on the way the layout owner wishes to operate it. From this it can be seen that the method selected from those described in the following pages needs to be determined at a fairly early stage of a layout's design.

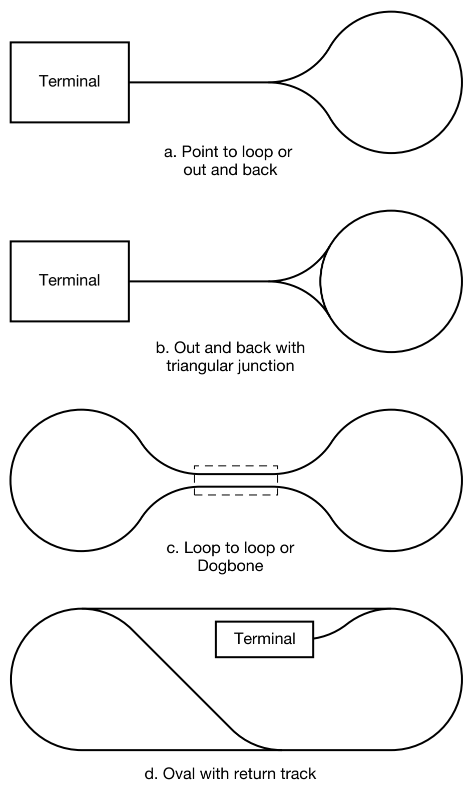

Figure 6-1 Four typical return track configurations.

6.2 Return Track Configuration

Return tracks occur in a number of layout designs and can create traps for the unwary. A popular garden layout design consists of a terminus in a shed leading to return loop and which, if required, can be operated by one person. The design can be a simple out and back loop (Figure 6-1a) or be connected by a triangular junction allowing the train to make several circuits before returning to base. (Figure 6-1b)

Another basic shape is the oval. A popular arrangement is to model a through station on one side and storage roads on the other. A variant on this shape is the loop to loop or Dog Bone, which is sometimes used to provide a means of modelling a through station that again can be operated by one person. (Figure 6-1c). Where a single terminal is connected to an oval it becomes necessary to provide means for the train to return to its starting point. This requires the use of a return track to turn the train. (Figure 6-1d)

6.3 Point to Loop

6.3.1 Single track loop

As explained above, when a train traverses a 2-rail return loop the basic problem is that the polarity of the main line power supply has to be reversed while the train is in the loop before it can regain the main line. Three solutions exist; two involve constraints on the method of operation while the third, though flexible, requires a modification to the control unit output.

Figure 6-2 shows a return loop with the loop track fed from a two-pole change over switch. This can be operated by the turnout as illustrated or by a separate toggle switch but the operation of switch and turnout needs to be co-ordinated. A train entering the loop has to be brought to a stand while the turnout is changed and the power supply to the main line reversed. It can then be driven out of the loop and back to the terminal.

A variation on this method is to feed the loop track from the control unit and the rest of the layout from the loop via the toggle switch. This can be confusing to operate as each time a train traverses the loop and the toggle switch feeding the rest of the layout is reversed, the control unit direction and its indication changes for the rest of the layout. However, if the loop includes a triangular junction it may be a simpler method of wiring. The choice depends on whether the layout is operated from the point of view of the single track, in which case directional consistency on this part of the layout is more important and the first method would be used, or from the point of view of the loop, when it is important that ‘forward’ is always the same direction on the loop and this second method is better. (See sub-section 6.3.3)

The second method makes use of a full wave rectifier to supply the return loop track from the main line. As illustrated in Figure 6-3, the terminals marked ac are connected to the main line and the dc terminals to the return loop. The track electrification standard is that with the right hand rail positive the train will move forward. Using the rectifier to supply the loop means that, in the case illustrated, a train can only travel anti-clockwise around it. While the train is on the loop the turnout and the polarity of the power supply to the main line can be reversed without having to bring the train to a stand. Once the train has regained the main line the turnout has to be returned to normal ready for the next arrival.

For turnouts having an insulated crossing and sprung blades (Lima turnouts are an example) the arrangement can be semi-automatic. If the loop is fed via a rectifier and the turnout set for entering

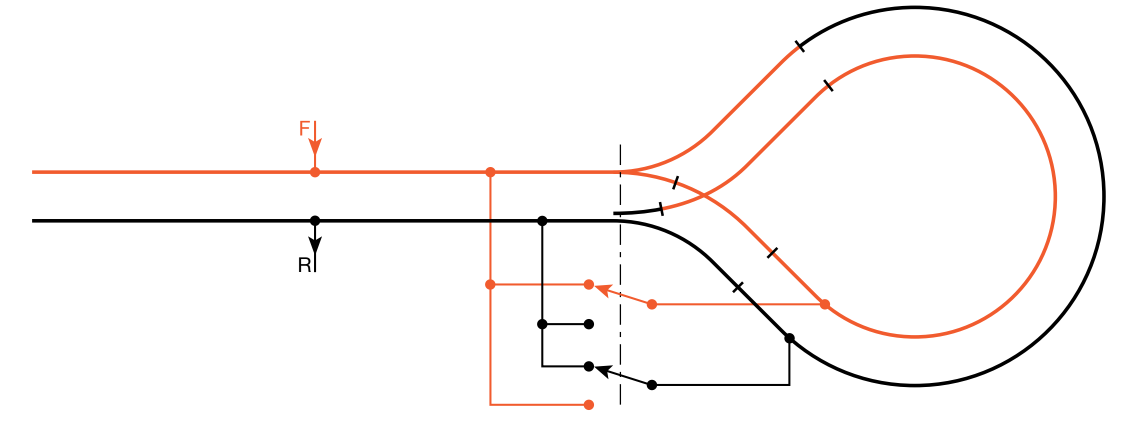

Figure 6-2 Simple reversing loop with polarity change over switch.

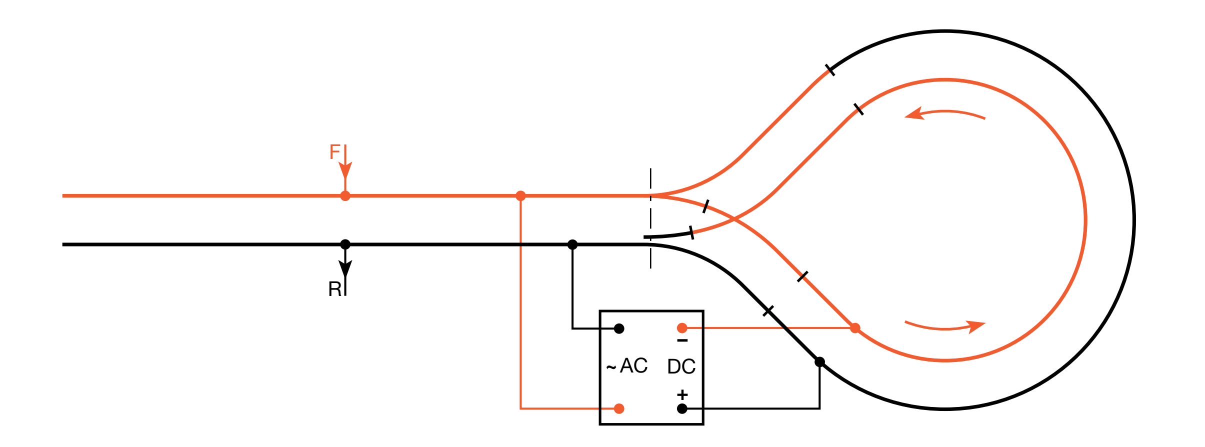

Figure 6-3 Return loop fed via a rectifier

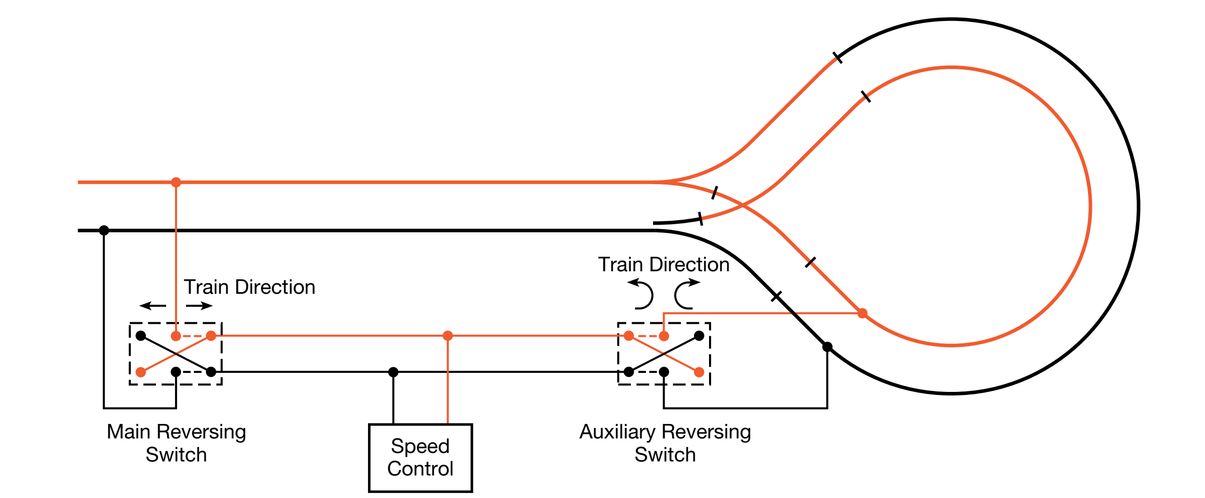

Figure 6-4 Loop polarity controlled by an auxiliary reversing switch.

the loop in the correct direction, all that is required is to reverse the power supply polarity while the train is traversing the loop.

The third arrangement, which is the most flexible and allows movement around the loop in either direction, requires the use of an auxiliary power reversing switch. The main problem is that the majority of commercial control units have the direction control switch built into the casing so that access is difficult. If it is possible to gain access to the wires leading from the speed control to the reversing switch, a connection can be made to a second, auxiliary, reversing switch. The loop track is supplied from this auxiliary reversing switch. The arrangement is illustrated in Figure 6-4.

If access cannot be obtained to the controller reversing switch, an alternative is to fix it in position, and add a pair of new direction switches externally.

As the train traverses the loop track, the turnout and the main direction switch can be reversed without affecting the train movement.

6.3.2 Polarity indication

Wiring a pair of lamps across the insulation boundaries gives an indication of the match between the rail polarities. (See Figure 6-5). In the illustration, the polarities match at the upper break causing lamp 1 – green – to be lit and lamp 2 – red – to be extinguished. Across the lower break the polarities are in opposition causing lamp 3 – red – to be lit and lamp 4 – green – to be extinguished. A green light indicates that a train can proceed across the boundary.

6.3.3 Single track loop with triangular junction

As shown in Figure 6-6, the power supply to this loop is supplied by a single control unit and an auxiliary switch. The method of operation would be similar to that described in version one above (Figure 6-2).

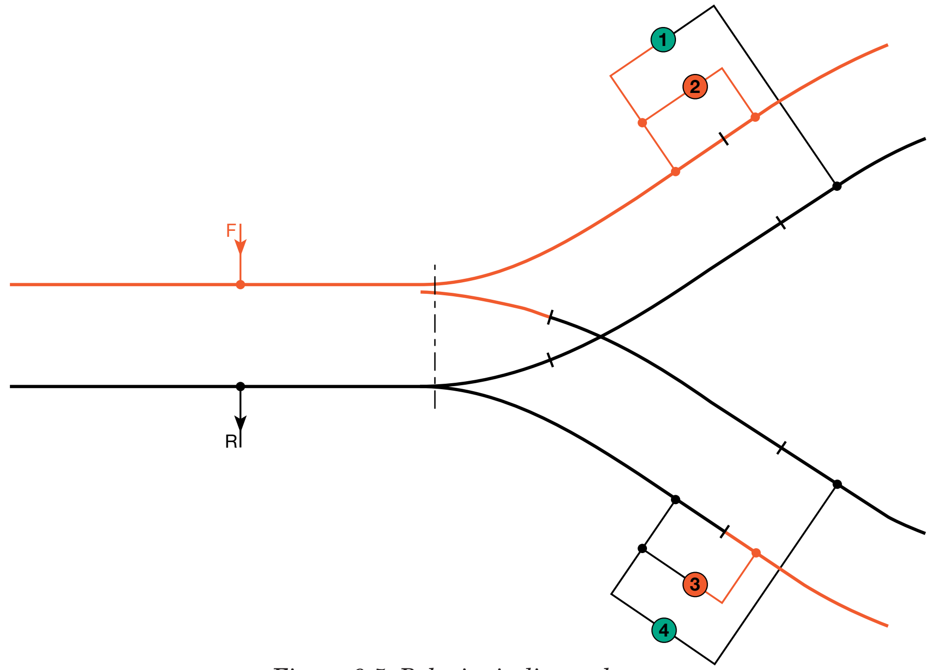

Figure 6-5 Polarity indicator lamps.

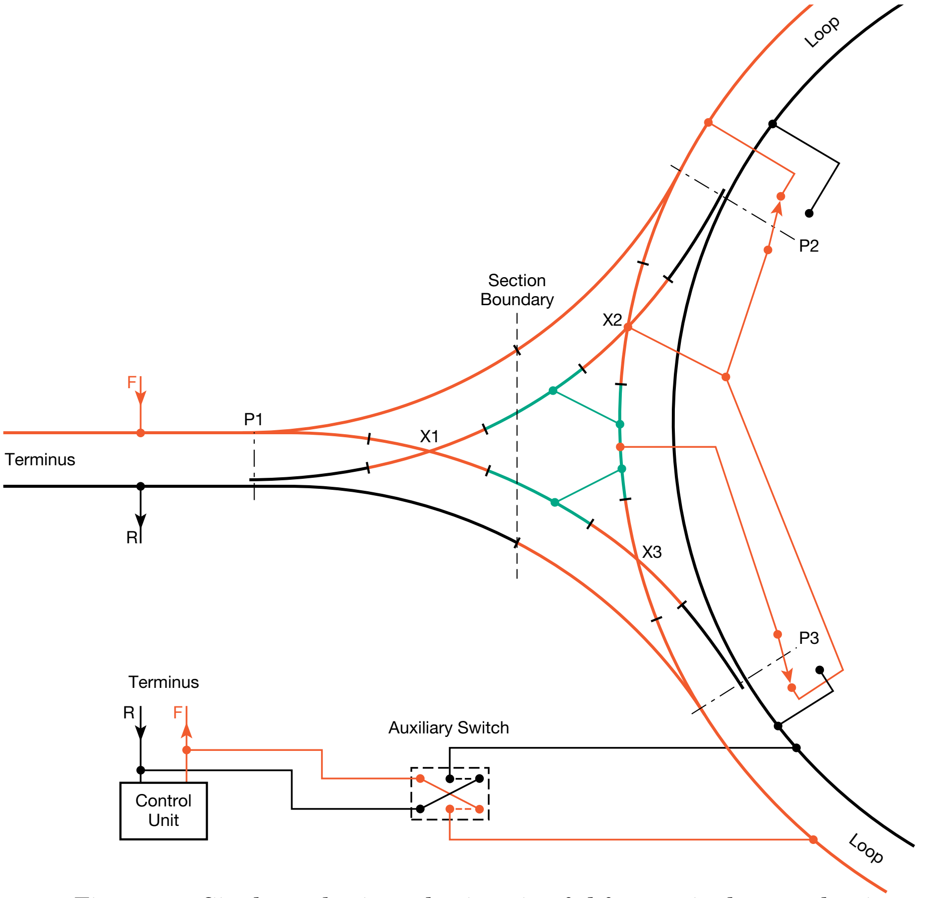

Figure 6-6 Single track triangular junction fed from a single control unit.

The only additional wiring would be to the section of rail shown in green, which would have its polarity determined by movements across the junction. Adopting the convention that turnouts P2 and P3 are normal when set for continuous running around the loop, only turnout P3 requires an additional tie-bar operated switch or similar device. (See Section 3, Turnout Wiring). The green 'floating polarity' section is normally fed from P2 crossing but reversing either P2 or P3, but not both at the same time, to allow a movement into or out of the continuous circuit changes its polarity.

Depending on the design of the layout, there could be two trains moving, one in the terminal area and one circulating round the continuous run. This would require the use of multiple control units and a means of passing the trains across the boundary between the two operating areas as described in Section 5. Section breaks would be as shown in Figure 6.7. Common return wiring can be using in this case, but note that when the train travels via spur A, the two controllers directions are matched, but when going via spur B, the directions are opposed (forward on X, reverse on Y, or vice versa). Either both rails must be broken at the section boundaries, and points individually wired, or the simpler circuitry of Figure 6.6 can be used, with the Y section supply replacing the auxiliary switch.

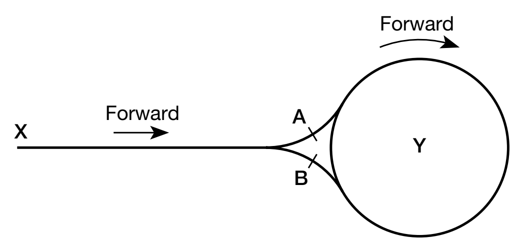

Figure 6-7 Junction fed from separate controllers.

6.4 Double track to loop

Figure 6-8 shows a simple terminus with up and down approach tracks connected by a return loop, a popular design for garden railways. In this configuration two approaches exist. In Figure 6-8 the feed rails are the upper rails and the return rails are the lower of the two. A train leaving the terminus along the up line and proceeding round the loop will find that the down line polarity is opposite and needs to be reversed to allow the train to return to the station. The electrical constraints are similar to those described for the single track loops in 6.2.1 above. However, in the absence of a turnout to reverse the supply connections, a separate change over switch is required. The train is driven into the loop and brought to a stand while the switch transfers the power supply to the exit main line; the down line in the illustration. If both main lines are fed from the same control unit this will also have to have its output polarity reversed to give the correct direction for running on the return track.

Where both main lines are fed from the same control unit, an alternative method would be to supply the loop via a full wave rectifier as described in sub-section 6.3.1 above. This would allow the train to operate without stopping, the supply to the station being reversed while the train is in the loop. The power source connected to the rectifier ac terminals could be taken from either the up line leading into the loop or the down line. The preference is for the supply to be taken from the down line (section F3), because if the up line is providing the power source, section F2 must remain connected to the control unit until the train has completely traversed the loop and reached the down line before being switched off.

The second approach depends on the way the layout is to be operated. If the main operations are concentrated in the station area, the station wiring will be arranged for ease of movement between the

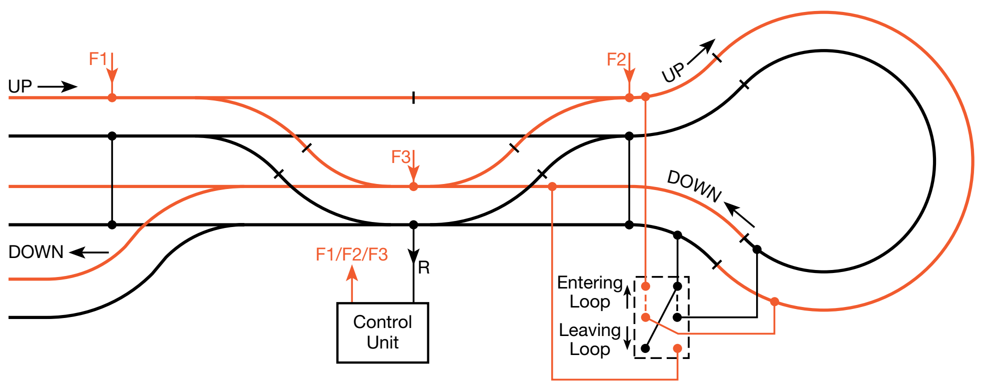

Figure 6-8 Double track loop supplied from main lines via a selector switch.

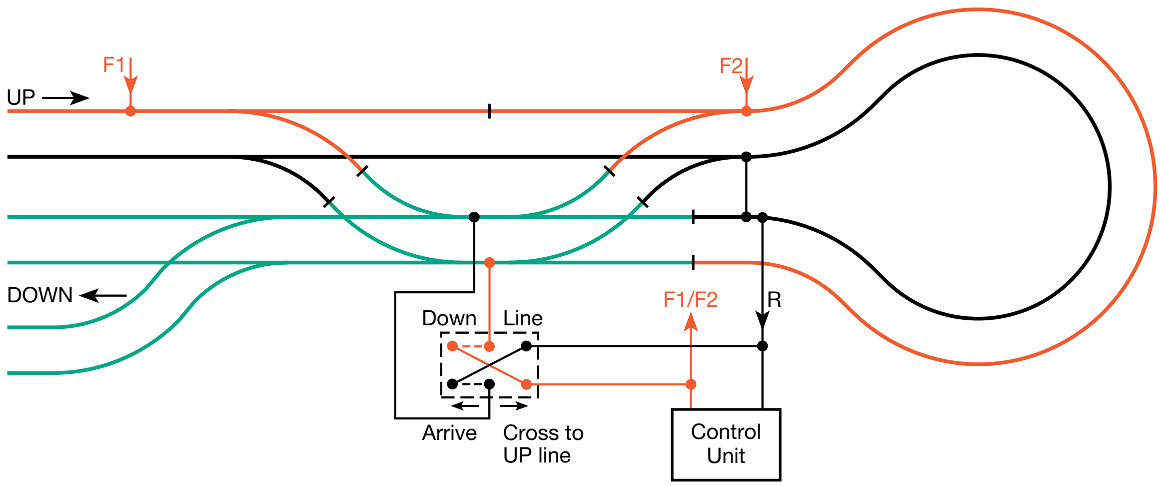

Figure 6-9 Double track loop with auxiliary switch to feed the down line.

two main lines and the wiring would follow the pattern described above. If the movements in the station area are subsidiary to movements along the main line, the feed and return rails would be continuous and the polarity changes take place within the station area. Figure 6-9 shows an auxiliary switch on the supply to the down line. This is in green to indicate that the polarity varies with the position of the 'through/local' switch. When set to through, trains can be driven from the up line, round the loop and back to the down line without changing the control setting. For movements between the up and down lines in the station the auxiliary switch is set to local so that the polarity of the down line matches the up line.

Figure 6-10 shows a double track leading to a loop and having a facing crossover. This could be to accommodate the bi-directional running in stations that is current operational practice. The electrical break between turnouts P1 and P2 would form the break between the main line and the loop. Power to the loop would be fed by a double pole change-over switch attached to turnout P1 as illustrated in Figure 6-2, enabling the train to traverse the loop in either direction.

Movement from section F1 around the loop anti-clockwise would require the train to be halted while the turnout and section F1 polarity are reversed to allow the journey to be completed. Similarly, clockwise movements would require a pause while either F1 or F2 are reversed to match the loop polarity. Continuous operation would be possible if sections F1, F2 and the loop formed individual control areas as described in Section 5, Multiple Controls.

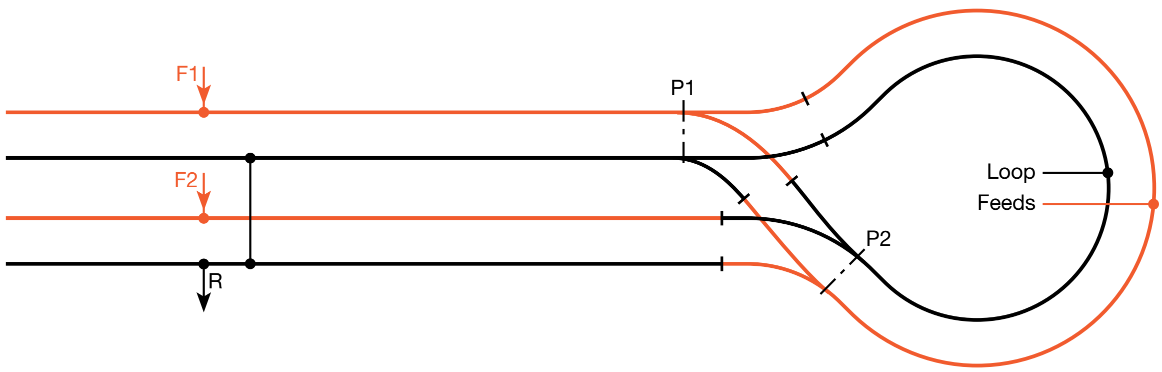

Figure 6-10 Double track loop with facing crossover.

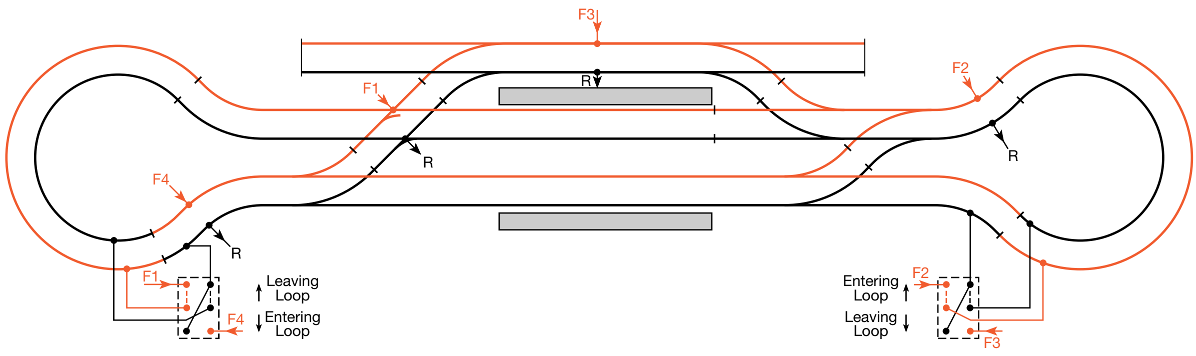

Figure 6-11 Through station with storage loops at each end.

6.5 Loop to loop or dogbone

The wiring of a loop to loop layout is similar to the double track loop described in 6.4 and can also be tackled in two ways. Depending on the operating requirements it can be organised either as a through line with storage loops at each end or as a continuous running circuit. Figure 6-11 shows a simple through station with storage loops at each end. The storage loops at each end will be fed via auxiliary switches, as illustrated, or a rectifier.

If the operational requirements are for continuous running and only occasional movement between the two main lines is required, the loops can be wired in with the main lines in a similar manner to that described in 6.4 and illustrated in Figure 6-9. In Figure 6-12 the outer rails of the main line are feed rails and the inner rails are return rails, so a train can run from one loop to the other and back again without any need to alter the control unit settings. When a movement across one of the crossovers is required, the feed and return connections to the green 'floating section' are reversed using the auxiliary switch so that the polarity matches that of the other main line.

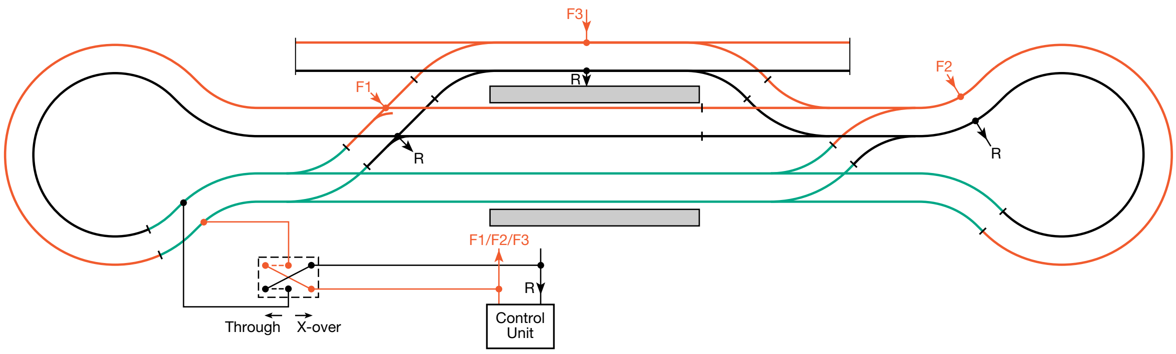

Figure 6-12 The section of main line in green is fed indirectly via the auxiliary switch to allow polarity changeover when crossing to the other main line.

6.6 Double track loop with Y junction

This formation can be treated in the same way as the simple double track loop in 6.4 above. The basic wiring of the junction is fully described in Section 3 and illustrated in Figure 3-16. Where the feed and return connections are the same as those in the illustration the loops will need to be fed via selector switches.

Where the loop forms part of a continuous running circuit, the second option described above can be used. Referring to Figure 3-16, the only variation needed to the connections shown are those to crossings X4 and X6. Because the down line feed and return connections are reversed compared to those shown in the illustration, crossing X4 could be permanently connected to a common return and crossing X6 would need to be switched.

6.7 Double track loop with triangular junction

A layout having a formation of this complexity would probably have two or more control units supplying power. Movements between control areas would use one of the linking systems described in Section 5. Like the double track loops described above, the location of feed and return rails would depend on the way the layout is designed to be operated. Figure 6-13 shows the variant where the feed and return rails are located on the same side to provide easy movements between up and down lines both in the terminal area and the continuous circuit. Polarity only needs to be checked for movements between F1 and F6 and between F5 and F2. (A to/from B).

The simplest way to approach the problem is to assume that the normal positions of turnouts P3/P4 and P5/P6 are for continuous running around the loop. Also, the interlocking is so arranged that only one of these two junctions can be fully reversed at a time. The polarity of the individual crossings, X1 to X6, would be determined by switches operated by their respective turnouts. Movements from section F1 to section F3 or from F4 to F2 only require their feeds to be connected to the same controller. Movements to or from the terminus to the loop across the diamonds would require the polarity of the green 'floating sections' to be altered. The key turnouts controlling the polarity of these 'floating sections', J1 to J6, are P4 and P6.

These changes can be made using two multipole switches or relays operated in conjunction with these two turnouts. The polarity of the 'floating sections' J1 to J6, can be determined by analysing the movements across the junction. Putting the results in tabular form helps to show where the changes occur. The table for Figure 6-13 is shown below.

From this the connections to the associated switches can be worked out. The result is shown on the side of Figure 6-13.

The other variant is where the layout is designed for out and back running without having to come to a stand. This is shown in Figure 6-14. Movements between the up and down lines in the terminus area would require 'arrive/cross to up line' switches as described above in 6.4. Similarly, a passing station on the loop having crossovers between the up and down lines would require a 'through/local' switch to permit movements across both lines as described in 6.5.

The number of 'floating sections' required in this junction is reduced to four (J1 to J4), again controlled by turnouts P4 and P6. The connections are shown at side of the diagram. Although the junction wiring is simplified, the need for floating sections in the Terminus and passing station areas makes the overall scheme for the layout more complicated.

Table for Figure 6-13

	Turnout position		**Power to floating sections from:**					
Movement	**P4**	**P6**	**J1**	**J2**	**J3**	**J4**	**J5**	**J6**
A to B	Normal	Normal	No changes required					
C to A	Normal	Normal	No changes required					
B to C	Normal	Normal	No changes required					
C to B	Normal	Normal	F5	F5	F5	-	CR	CR
B to A	Reverse	Normal	CR	F4	CR	F4	F4	-
A to C	Normal	Reverse	F6	CR	CR	F6	-	F6

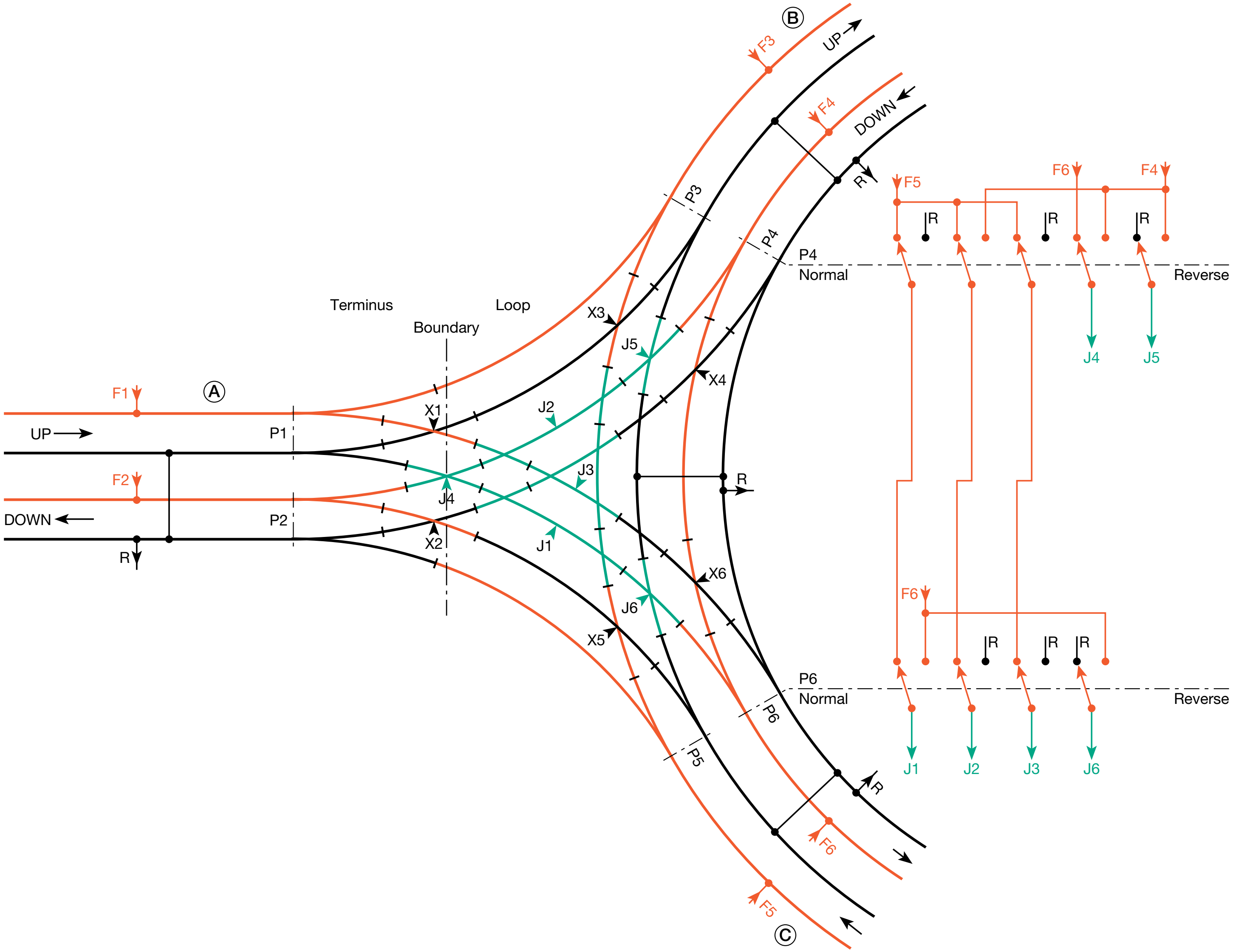

Figure 6-13 Double track loop and triangular junction.

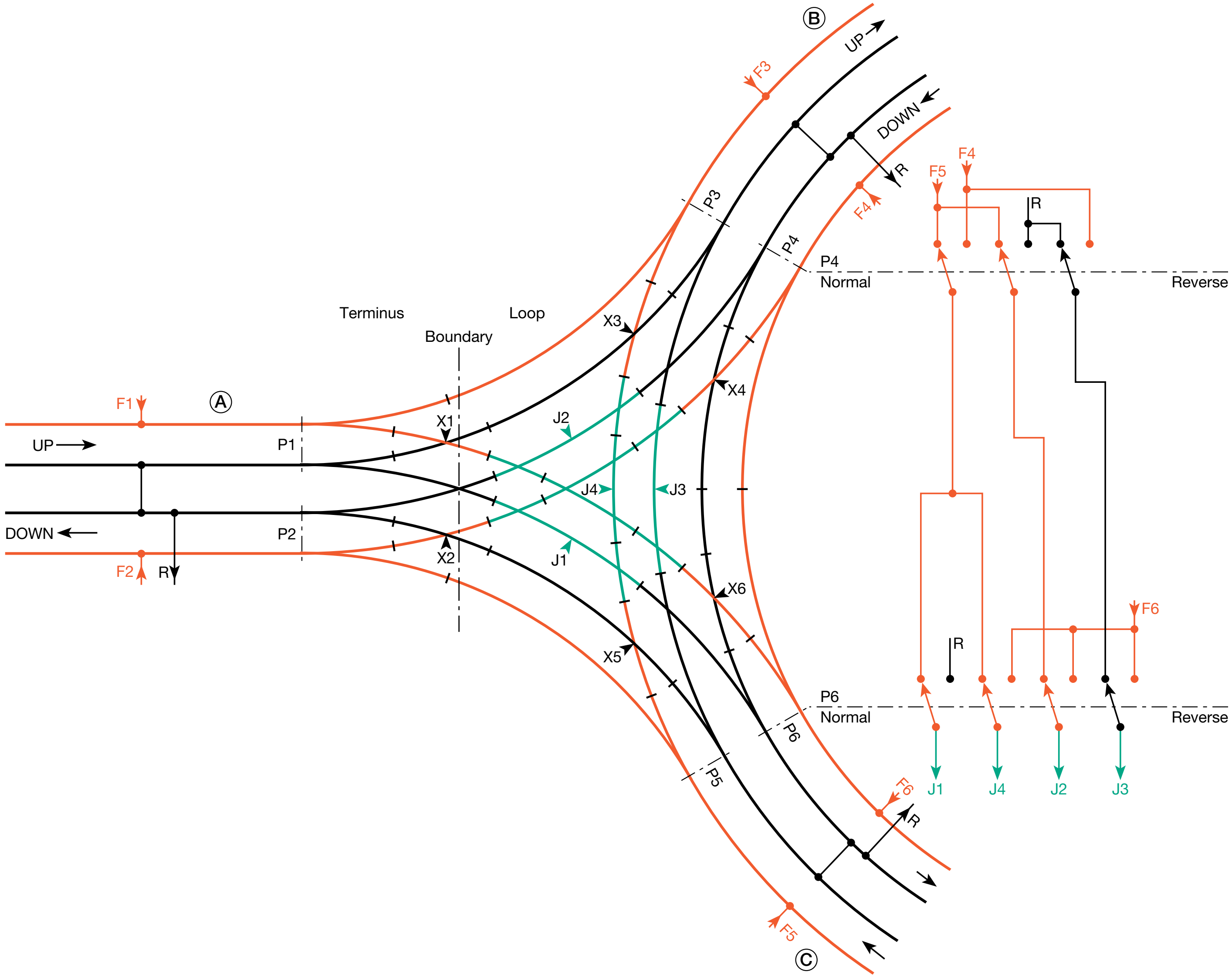

Figure 6-14 Double track loop and triangular junction variation.

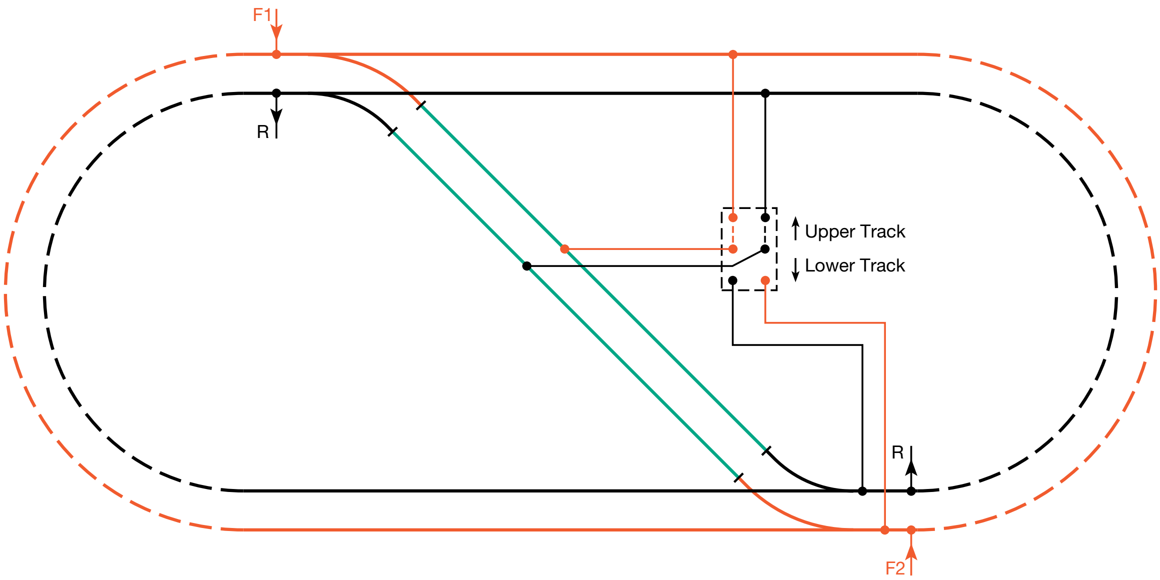

Figure 6-15 Return or reversing track forming part of an oval.

6.8 Oval layout return track

The operational procedure here is similar to that of the double track return loop. The auxiliary switch is set towards the turnout where the train will enter the return track. Once the train is on the track it is brought to a stand while the auxiliary switch transfers the power supply to the exit side of the circuit. Figure 6-15 shows the connections. Assuming that the return track is long enough to hold a complete train, an auxiliary switch with a centre-off position would allow the train to be held until it was required to re-appear in the operating sequence. For non-stop operation where the return track is only operated in one direction, a full wave rectifier can substitute for the reversing switch.

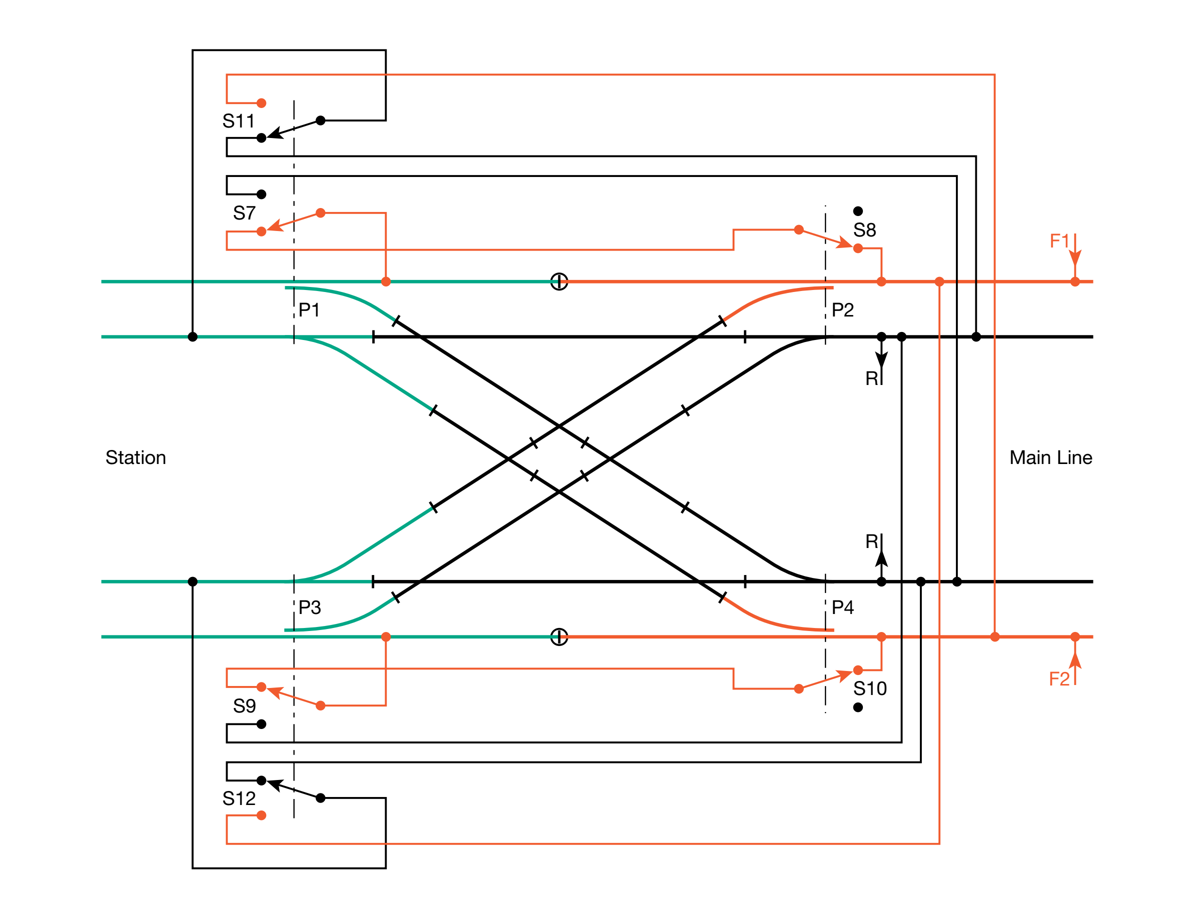

Figure 6-16 Scissors Crossover used for route setting.

6.9 Scissors Crossovers

In Section 6.4, the illustrations, Figures 6-8 and 6-9, show the connections between the up and down lines as facing and trailing crossovers. Where space is at a premium the two crossovers can be replaced with a scissors crossover. The full wiring of scissors crossovers is illustrated in Section 3, Figures 3-19a and 3-19b. Referring back to those two figures, with the control unit connected to the feeds and returns as shown the storage loop would need to be supplied via an entry/exit switch similar to the one shown in Figure 6-8. A train would have to be brought to a stand in the loop while the main line polarity was switched.

If the layout is intended for a continuous movement through the loop, feed supply F2 and its associated return rail in Figure 3-19a would become 'floating' rails fed via an arrival/cross over switch as shown in Figure 6-9.

6.9.1 Route setting via scissors crossovers

It is possible to combine continuous movement around the return loop and route setting within the station area to minimise the number of section switches on the control panel. The scissors crossover illustrated in Figure 3-19b on Page 8-3-13 has 10 auxiliary switches operated either by the turnout tie bars or an associated relay system. These provide power to crossings X1 to X4 and also route power to the station terminal roads from either the departure or arrival track power connections. If the layout is operated as a continuous out and back movement, feed supply F2 and its associated return connection to the lower rails would be reversed compared with Figure 3-19b. This configuration is illustrated in Figure 6-16. Because of the altered connections to the arrival track, to achieve route setting using the turnout positions requires two additional change-over switches (S11 and S12) plus an isolation gap in the lower feed rail as well as the one in the upper feed rail (circled).

To avoid cluttering the diagram the auxiliary switches S1 to S6, which are required to provide the correct polarity to crossings X1 to X4, have been omitted as they are fully illustrated in Figures 3-19a and 3-19b.